THE EAST-WEST TRANSITION OF THE FLORA IN TEXAS: A BIOGEOGRAPHICAL ANALYSIS

Michael H. MacRoberts and Barbara R. MacRoberts

Bog Research, 740 Columbia
Shreveport, LA 71104, U.S.A.
and
Herbarium, Museum of Life Sciences
Louisiana State University-Shreveport
Shreveport, LA 71115, U.S.A.

ABSTRACT

Quantitative methods were used to determine the transition zone between the eastern and western flora in Texas. The transition between the southeastern deciduous/coniferous forest region and the western plains/brushy-savanna is a 300 km wide area extending from around 95 degrees to 99 degrees west longitude. Across this area, eastern and western species drop out precipitously; this area is the range edge for the two floras. This finding agrees closely with earlier vertebrate biogeographic analyses.

KEY WORDS: West Gulf Coastal Plain, flora, biogeography, east-west floristic transition, Texas

RESUMEN

Se usaron métodos cuantitativos para determinar la zona de transición entre la flora oriental y occidental en Texas. La transición entre la región sur oriental de bosques deciduos/coníferas y la occidental de llanuras/sabana arbustiva es un área de 300 km de ancha que se extiende desde unos 95 grados a 99 grados de longitud oeste. A través de esta área, las especies orientales y occidentales se separan precipitadamente; esta área es el extremo del rango de las dos floras. Este hallazgo concuerda en gran medida con análisis biogeográficos realizados previamente.

INTRODUCTION

Despite the fact that the North American coastal plain is one of the continent's major floristic provinces (Dice 1943; Takhtajan 1986), quantitative papers on its phytogeography are poorly represented in the botanical literature (Sorrie & Weakley 2001). Even more poorly represented are such papers on the West Gulf Coastal Plain (MacRoberts et al. 2002; MacRoberts & MacRoberts 2003). While several quantitative studies are now available on endemism within the coastal plain (Sorrie & Weakley 2001; MacRoberts et al. 2002), studies on diversity, species richness, dispersion barriers, and floristic boundaries are lacking (Currie 1991; MacRoberts & MacRoberts 2003).

It has been long known that the eastern part of the West Gulf Coastal Plain (east Texas, south Arkansas, west Louisiana, southeast Oklahoma) is part of the eastern and notably the southeastern United States (Thorne 1993; Christensen 2000; Delcourt & Delcourt 2000), but it is unclear where the floristic east-west

SIDA 20(4): 1693–1700. 2003

transition occurs. An examination of the ecoregional literature indicates a rather confused picture of this transitional area (MacRoberts & MacRoberts 2003).

The purpose of this paper is to determine where floristic east meets west in the West Gulf Coastal Plain.

METHODS

1) In order to obtain a characteristic sample of the southeastern flora at the same latitude as Texas, we used Kartesz and Meacham (1999) to determine the distribution of all North American vascular plants whose distribution includes Georgia, Florida, Alabama, and Mississippi (although not necessarily restricted to that area) and that cross the Mississippi River into Louisiana and/or Texas (although not necessarily restricted to that area). Thus, species restricted to only the above listed states are included (e.g., *Xyris drummondii* Malme) as well as those found in all of the contiguous 48 states and Canada (e.g., *Potamogeton pusillus* L.). Exotic species and hybrids are excluded. Subspecies and varieties are lumped with species. Species whose taxonomic status or distribution was questionable are excluded. Our initial data set contained 1320 species.

Since there is no thorough county-by-county floristic inventory of the West Gulf Coastal Plain, we used a single source of data, which consists of samples from those counties. We plotted the distribution of species that met our criterion by Texas counties using the Texas Consortium database (TAMU-BWG Herbarium Specimen Browser, a consortium of seven Texas herbaria with 130,000 records online). Of the 1320 species in the initial data set, 1138 were in the TAMU database by county. In the preliminary analysis all data were converted to percentages because the counties have been unevenly collected and reported. Thus, Bowie County had 489 species in the TAMU database, of which 302 were from our data set (302/489 = 0.62) and Madison Co. had 1016 species, of which 452 were from our data set (452/1016 = 0.44).

2. In order to do the same thing but from a west-to-east perspective, we sampled the western flora by roughly the same methods as described above. Because both New Mexico and Mexico border Texas on the west, we selected three counties in west Texas (Taylor, Tom Green, Edwards), listed the species found in them from TAMU data base, and randomly selected 313 from the list on the basis of their western affinity (found in west Texas, New Mexico and/or Mexico [TAMU; Kartesz & Meacham 1999]). We used a much smaller sample from the west because we realized that the eastern sample was larger than necessary. Because the sample is smaller, to make numbers comparable with the east we multiplied the percentages by 2.

We then converted all of the county data in 1 and 2 above to the Owen and Schmidly (1986) quadrat system for Texas to standardize area and to even out irregular county boundaries and percentages. This also allowed us to use Owen and Schmidly's data on environmental variables of biological importance. The quadrats are 63.9 km on a side, overlaid on a Lambert's conical projection map of Texas. We converted the county data to quadrat data by overlaying the quadrat map onto our county map and then averaging the percent of species of the counties that occurred in each quadrat.

3) Having found a clear east-west transition zone from the results of numbers 1 and 2 (see below), we wished to document the floristic affinities of Texas along an east-west gradient more thoroughly. To do this, we selected four Texas counties (Tyler, Madison, Bell, Irion) running across Texas at approximately 31 degrees North latitude and sampled them to determine their floristic relationship to the surrounding states. Using the TAMU database, we selected a random list of between 200 and 250 native species from each county. We then plotted the United States/Canada distribution of all species in the four lists using Kartesz and Meacham (1999). As before, the results are expressed as percentage of the sample (e.g., Louisiana had 97 percent of the species in Tyler County).

RESULTS

Figure 1 shows the percentage of eastern and western species in samples according to longitude across Texas. Figure 2 shows these data summarized for Owen and Schmidly (1986) quadrats by ten percent intervals. Figure 3 shows the distribution across North America of the flora of four Texas counties.

DISCUSSION

An examination of the shape of the curves in Figure 1 and the gradient expressed in Figure 2 shows that along Texas' 1250 km east-west axis, the area of most significant change in eastern and western species is the approximately 300 km wide zone from Houston and Tyler on the east (approximately 95 degree W. longitude) to Wichita Falls and San Antonio on the west (approximately 99 degrees W. longitude). On either side of this area, the change is gradual. According to our analysis, Fort Worth, Austin, and Corpus Christi appear to be the point at which east and west are balanced (97 degrees West longitude).

The relationship between county affiliation in the broader context of the entire North American continent north of Mexico shows the same pattern. Tyler County in east Texas is floristically eastern. Madison County farther west is mainly eastern, Bell County in the center of the transition zone is intermediate, and Irion County in the west is western (Fig. 3).

While ours is not a study of species richness, ecoregion boundaries, or diversity, nor is it concerned with cause of the species transition, it has implications for such studies. For example, Currie (1991) in a study of species richness has shown that the east-to-west loss of tree species across the gulf coastal plain correlates most strongly with actual evapotranspiration, which is correlated with primary production and is, therefore, a measure of available environmental energy.

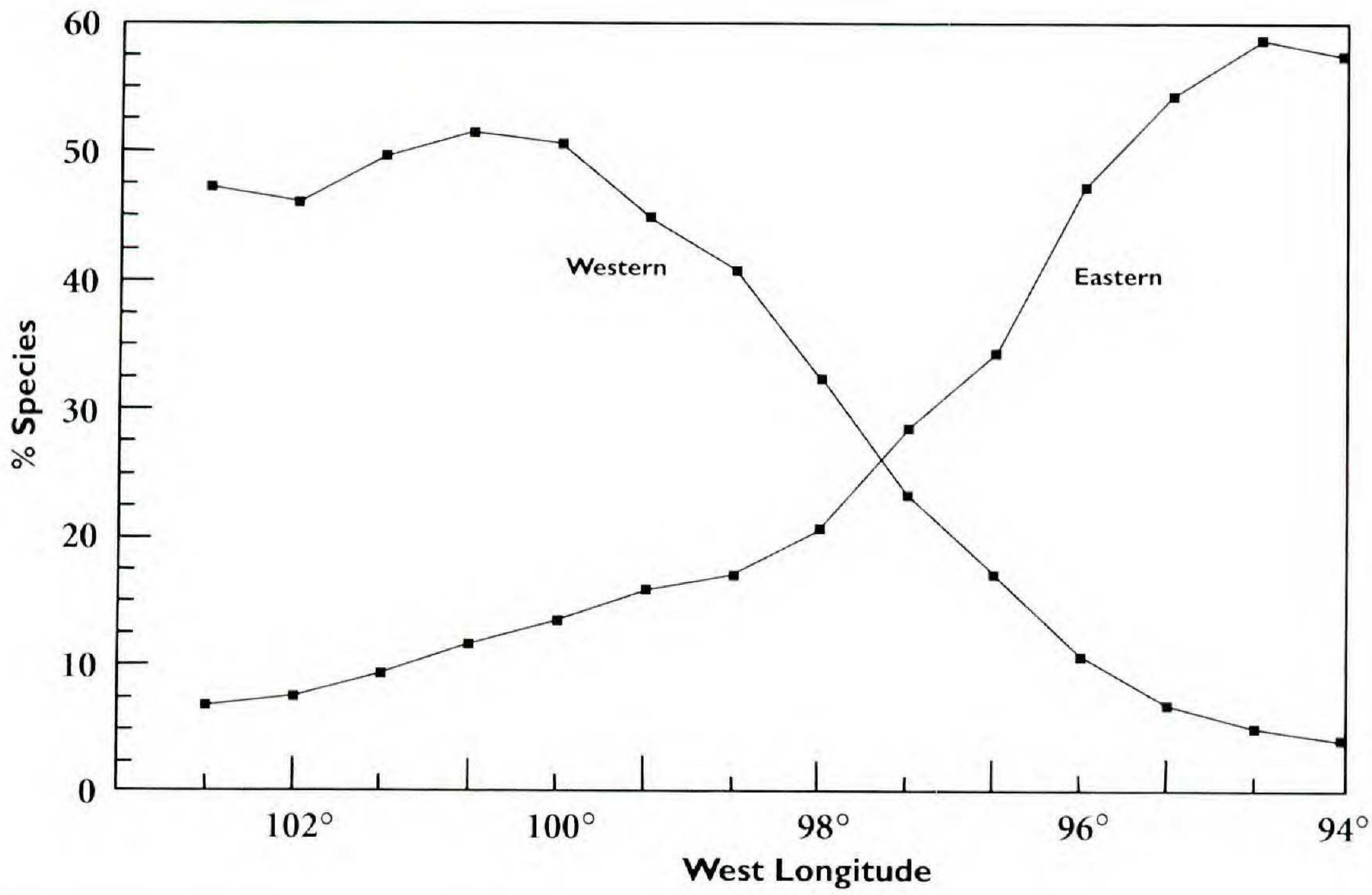

Fig. 1. Percentage of eastern and western species in samples according to longitude across Texas.

Our study also indicates that similar variables are important in determining species distribution in the West Gulf Coastal Plain. Using Owen and Schmidly's (1986) data, we calculated the correlation coefficient of "productivity" for eastern and western species and found a strong correlation between productivity across Texas and the number of eastern and western species. Eastern species correlated positively (Pearson = 0.91, Spearman = 0.92) while western species correlated negatively (Pearson = - 0.82, Spearman = - 0.77). The transition zone between east and west is after all the precipitation transition zone as well.

Central Texas has long been known to be an east-west transition zone, at least for vertebrates (Blair 1950; Webb 1950; Gehlbach 1991; Ward et al. 1994; Schmidly 2002). Dice (1943) referred to this area as the "Texan Biotic Province" between the eastern forest region ("Austroriparian") and the semi-arid brushy/savanna-grasslands ("Comanchian") of the western part of Texas. Blair (1950) recognized that the "Texan" was a "transitional region"—even using the word "ecotone"—but could find no alternative but to keep it a distinct province. Gehlbach (1991) solved the problem simply by pointing out that central Texas is a transition zone, not a biotic province, between the eastern deciduous forest region (Austroriparian Biotic Province) and western semi-arid brushy-savanna region (Comanchian Biotic Province). Characteristic plants and animals of both the Comanchian and Austroriparian occur locally in the Texan. More recently, Diggs et al. (1999:4) have characterized north central Texas floristically as "a

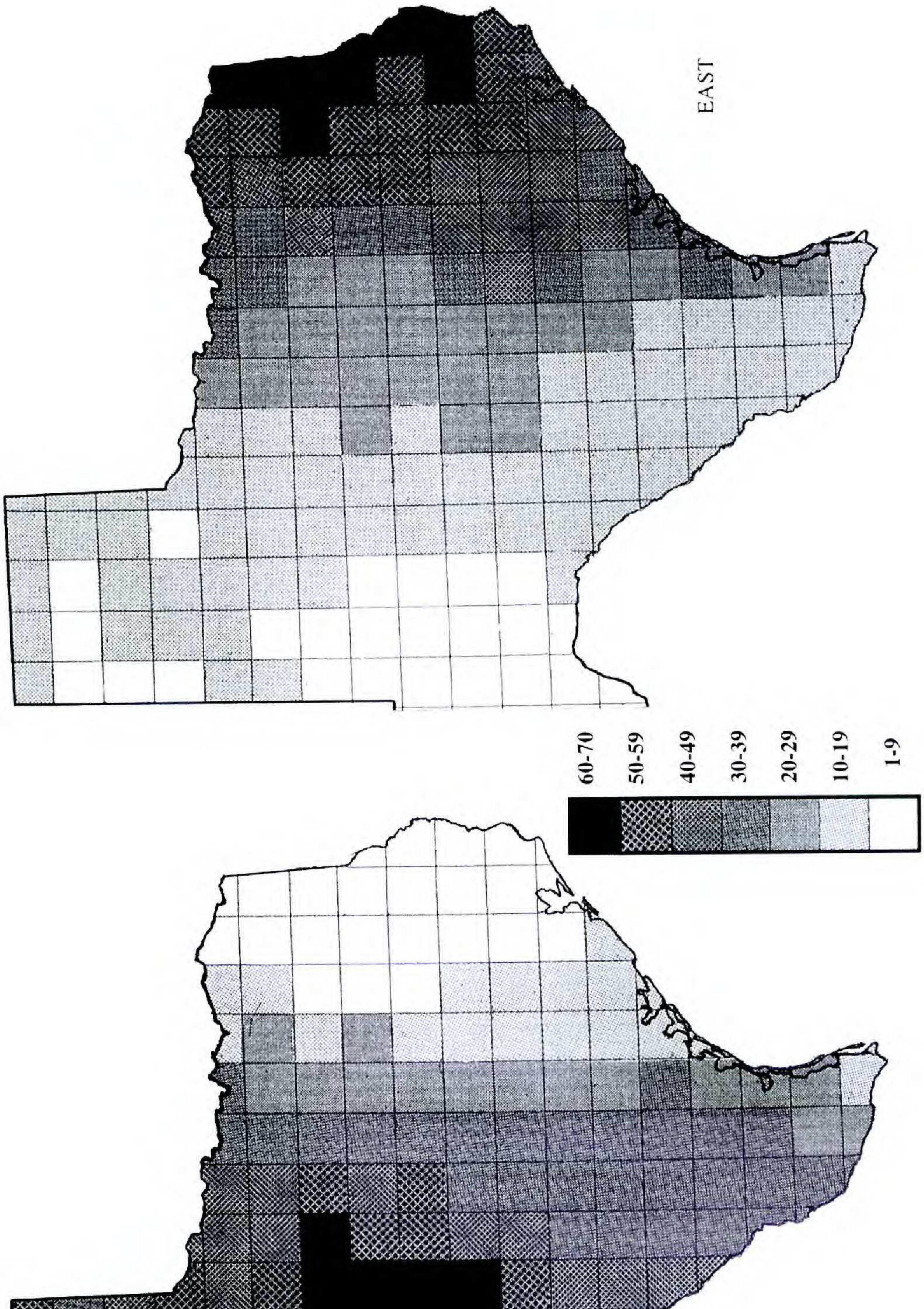

FIG. 2. Percentage of eastern and western species in samples according to Owen and Schmidly (1986) quadrat system at ten percent intervals.

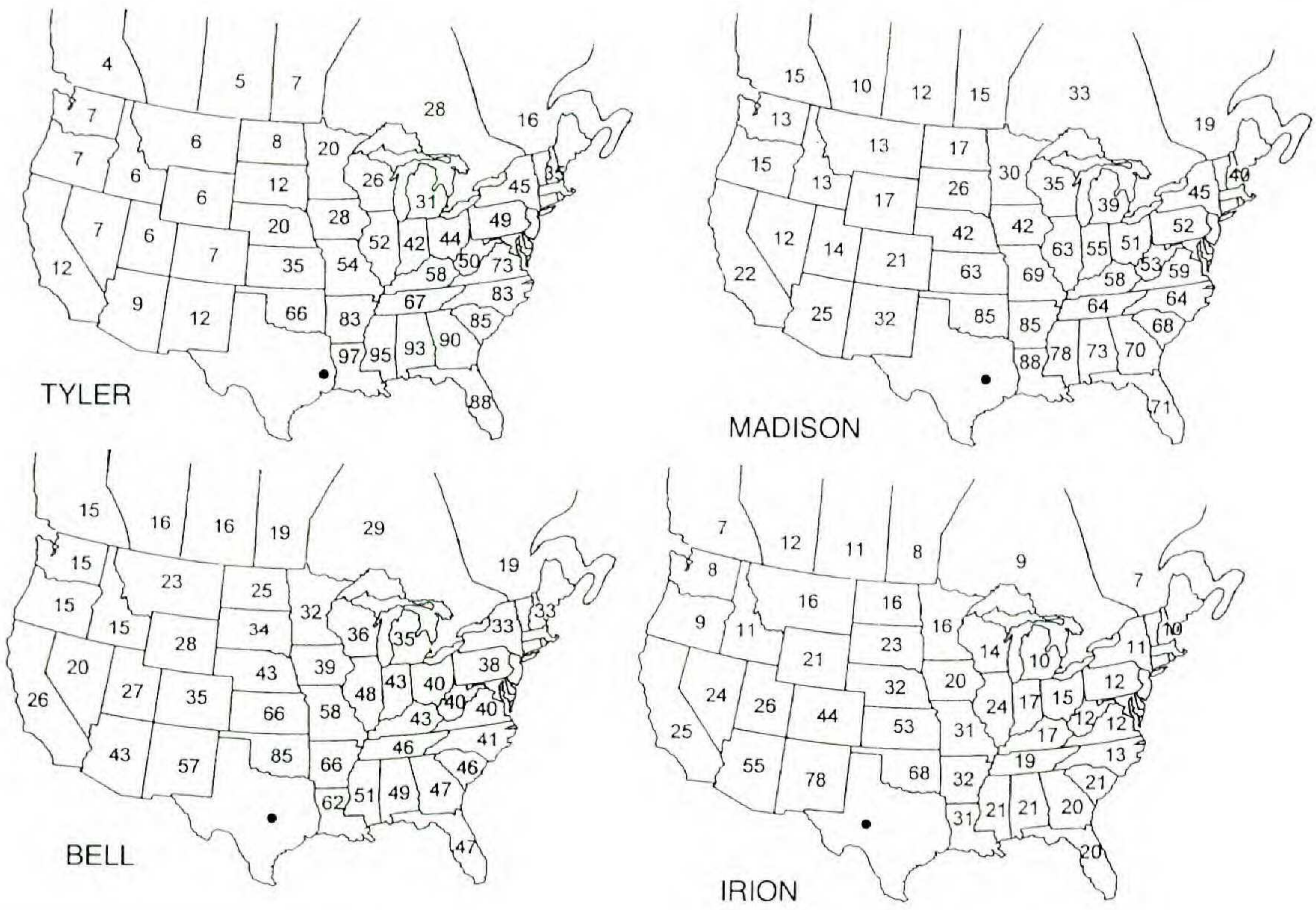

Fig. 3. Percentage of states, provinces, and geographical areas having species in samples from Tyler, Madison, Bell, and Irion counties, Texas.

broad ecotone between eastern deciduous forest and western grassland." We concur with these characterizations. From a floristic perspective, there is an east-west transition in the area roughly designated as Texan Biotic Province.

Paleoenvironmental studies indicate that the current floristic character of Texas may be fairly recent. Pleistocene and Holocene climatic changes appear to have been significant with the invasion of the West Gulf Coastal Plain by southeastern and Mexican species since the last glacial retreat (Bousman 1998; Delcourt & Delcourt 2000).

We do not consider our overall findings particularly novel. Years ago, zoologists came to basically the same conclusions based on vertebrate distribution. West Gulf Coastal Plain botanists, however, have been slow to address biogeographic questions quantitatively. As a result, botanists and botanically inclined ecologists have created a plethora of qualitatively defined "ecoregions" across Texas (Webb 1950; MacRoberts & MacRoberts 2003). We believe that zoologists currently have a better understanding of the biogeographic regions of Texas than do botanists, but improved plant distributional data (e.g., Turner et al. 2003) and the replacement of qualitative by quantitative methods of investigation should soon provide botanists with the opportunity to rectify this situation. With better data, and thus the ability to make finer comparisons, it will be interesting to see just where the transition is most pronounced and how west and south Texas separate from the remainder of Texas and the southeast.

ACKNOWLEDGMENTS

Laurence M. Hardy aided with the figures. Bruce Sorrie commented on an earlier version of the paper. Thanks also to Guy Nesom and Fred Gehlbach for their reviews of the manuscript.

REFERENCES

Blair, W.F. 1950. The biotic provinces of Texas. Texas J. Sci. 2:93–117.

Bousman, C.B. 1998. Paleoenvironmental change in central Texas: the palynological evidence. Plains Anthropologist 43:201–219.

Christensen, N.L. 2000. Vegetation of the southeastern coastal plain. In: M.G. Barbour and W.D. Billings, eds. North American terrestrial vegetation. Cambridge Univ. Press, New York. Pp. 397–448.

Currie, D.J. 1991. Energy and large-scale patterns of animal- and plant-species richness. Amer. Naturalist 137:27–49.

Delcourt, H.R. and P.A. Delcourt. 2000. Eastern deciduous forest. In: M.G. Barbour and W.D. Billings, eds. North American terrestrial vegetation. Cambridge Univ. Press, New York. Pp. 357–395.

Dice, L.R. 1943. The biotic provinces of North America. Univ. Michigan Press, Ann Arbor.

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Shinners & Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. 16:1–1626.

Gehlbach, F.R. 1991. The east-west transition zone of terrestrial vertebrates in central Texas: a biogeographical analysis. Texas J. Sci. 43:415–427.

Kartesz J.T. and C.A. Meacham. 1999. Synthesis of North American flora. Version 1.0. North Carolina Botanical Garden, Chapel Hill.

MacRoberts, M.H., B.R. MacRoberts, B.A. Sorrie, and R.E. Evans. 2002. Endemism in the West Gulf Coastal Plain: importance of xeric habitats. Sida 20:767–780.

MacRoberts, M.H. and B.R. MacRoberts. 2003. West Gulf Coastal Plain ecoregions. Sida 20:1247–1276.

Owen, J.G. and D.J. Schmidly. 1986. Environmental variables of biological importance in Texas. Texas J. Sci. 28:99–117.

Schmidly, D.J. 2002. Texas natural history: a century of change. Texas Tech Univ. Press, Lubbock.

Sorrie, B.A. and A.S. Weakley. 2001. Coastal plain vascular endemics: phytogeographic patterns. Castanea 66:50–82.

Takhtajan, A. 1986. Floristic regions of the world. Univ. California Press, Berkeley.

TAMU (www.csdl.tamu.edu/FLORA/tracy2/main1.html).

Thorne, R.F. 1993. Phytogeography. In: Flora of North American Editorial Committee, ed. Flora of North America. Vol. 1. Oxford Univ. Press, New York. Pp. 132–153.

Turner, B.L., H. Nichols, G.C. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Sida, Bot. Misc. 24:1–888.

Ward, R., E.G. Zimmerman, and T.L. King. 1994. Environmental correlations to terrestrial reptilian distribution in Texas. Texas J. Sci. 4:21–26.

Webb, W.L. 1950. Biogeographical regions of Texas and Oklahoma. Ecology 31:426–433.